UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON, D. C.
H. H. BENNETT, CHIEF

ADVANCE REPORT

on the

SEDIMENTATION SURVEY OF LAKE TANEYCOMO
TANEY COUNTY, MISSOURI

July 23 - November 2, 1935

by

Thomas L. Kesler

Division of Research
Section of Hydrodynamic Studies

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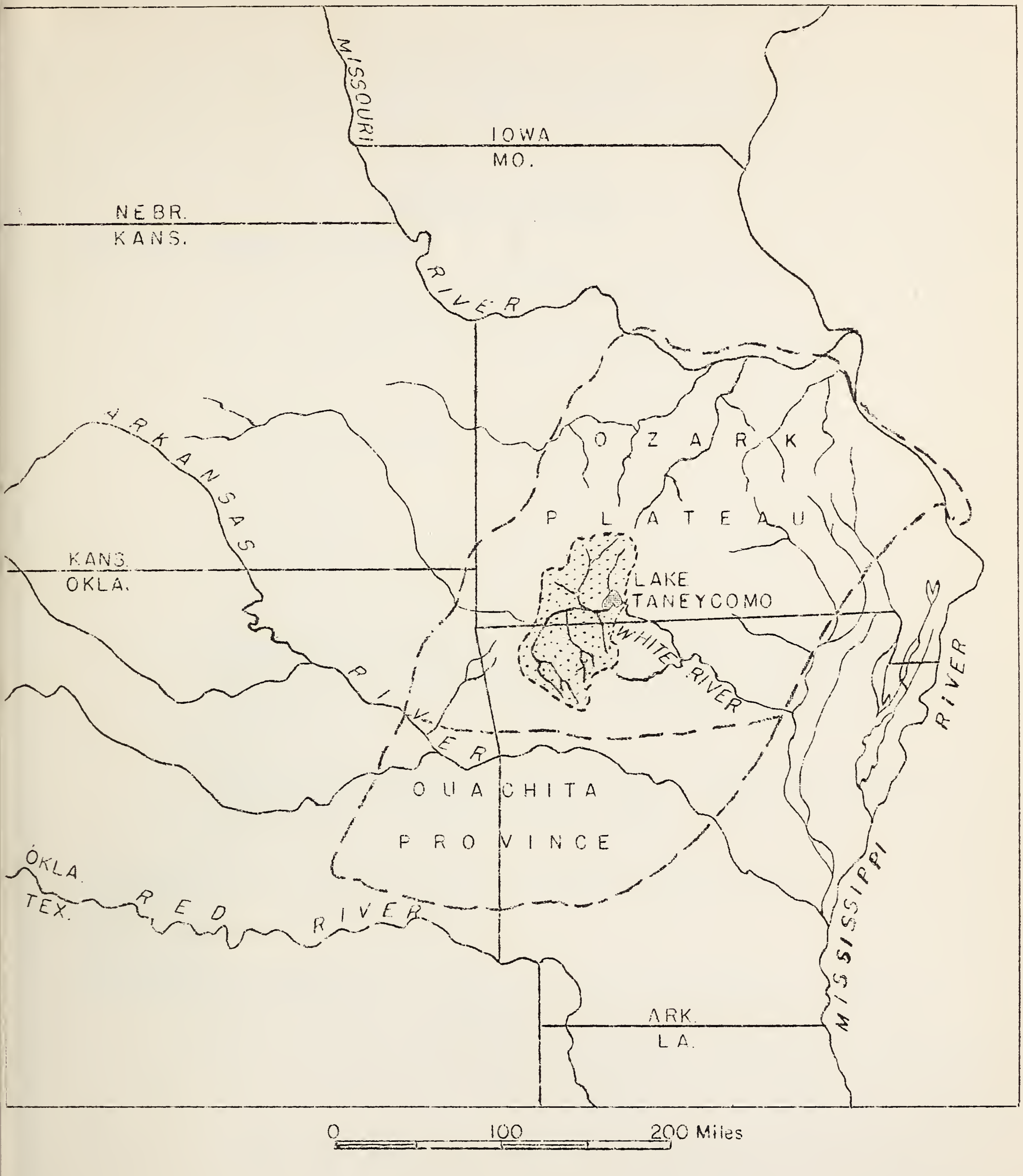

INDEX MAP SHOWING
LOCATION OF
LAKE TANEYCOMO

LEGND

RESERVOIR

WATERSHED

PHYSIOGRAPHIC BOUNDARY

ADVANCE REPORT ON THE
SEDIMENTATION SURVEY OF LAKE TANEYCOMO
TANEY COUNTY, MISSOURI

GENERAL INFORMATION

Location: State: Missouri.

County: Taney, lying within the following:

(1) T. 23 N., R. 20 W., secs. 5, 6, 7, 8, 17, 18.

(2) T. 23 N., R. 21 W., secs. 10, 11, 12, 13, 14, 15, 21, 22, 25, 27, 28, 33.

(3) T. 24 N., R. 20 W., secs. 19, 20, 29, 30, 31, 32.

(4) T. 22 N., R. 21 W., secs. 4, 5, 6, 7, 18.

(5) T. 22 N., R. 22 W., secs. 12, 13.

Distance and direction from nearest city: Approximately 50 miles south of Springfield, Mo. Branson, the largest town in Taney County, is located on the upper portion of the lake.

Drainage and backwater: White River, an important member of the Arkansas drainage system. Water is also impounded in Bull Creek, a tributary of the White.

Ownership: Empire District Electric Company, Joplin, Mo.

Purpose served: Electric power.

Description of the dam: The dam has an over-all length of 1,220 feet, including power plant on the east end (230 feet), reinforced concrete spillway (590 feet), and earth fill on the west end (400 feet). The height above stream bed is 50 feet. The spillway is the chief feature of the dam, and has an elevation of 698.73 feet above sea level as determined in this survey from a nearby U. S. Geological Survey benchmark. Flashboards have been maintained on the spillway about 60 percent of the time since 1924, but are usually swept out during winter and spring storm periods, the only periods of appreciable sediment transportation. From 1913 to 1924 their use was negligible. Due to their slight effect on sedimentation, therefore, the flashboards were not considered in capacity determinations. Those in use at the time of this survey were 30 inches in height.

Date of completion: March 1913. Average date of survey August 1935. Age to date of survey 22.4 years.

Length of lake:

Original	20.11 miles on White River. 2.46 miles of backwater in Bull Creek.
Present	20.11 miles on White River. 2.46 miles on Bull Creek.

Area of lake at crest stage:

Original		2,413.83 acres
Present		1,859.82 acres
	Reduction	554.01 acres

Storage capacity at crest level:

Original		43,980 acre-feet
Present		23,714 acre-feet
	Loss due to silting	20,266 acre-feet

General character of reservoir basin: Lake Taneycomo is strictly a channel reservoir having a long and sinuous course. Relatively narrow flats or bottom lands occur at intervals but, for the most part, the basin itself is bounded by valley sides ranging from moderate slopes to vertical bluffs rising as much as 200 feet above crest level.

Area of watershed: 4,610 square miles.

General character of watershed: Essentially horizontal strata underlying the drainage area of Lake Taneycomo have been eroded in a drainage pattern typical of the incised Ozark Plateau. Great thicknesses of limestone of Beekmantown (lower Ordovician) age outcrop on the slopes and bluffs immediately about the reservoir, and show the effects of extensive solution. Farther back, the high country composing the greater part of the watershed is made up of the Boone limestone of lower Mississippian age. Uppermost reaches in northwestern Arkansas drain both the overlying Chester sandstone, shale, and limestone of Mississippian age and the lowest beds of the Pennsylvanian.

The Ozarks in the watershed are of moderate elevation, averaging about 1,000 to 1,500 feet above sea level. Intricate dissection of the upland has rendered much of the watershed highly unsuited to agriculture. Several farming areas occur where shales are apparently present in sufficient volume to permit softening of the slopes and accumulation of deep soil. An area of this type lies within southern Barry and Stone Counties, Mo., and northern Carroll County, Ark.

With the exception of these farming communities the remainder of the Taneycomo watershed is characterized by thin rocky soil. The soil itself consists generally of a fine silt loam containing much organic matter from the scrub forests. The soil hardly suffices to cover a mantle of weathered chert and limestone fragments

which, in turn, covers the bedrock below. Widening of major valleys has permitted accumulation of alluvial soil, and such localities are farmed but are subject to flood damage unless of sufficient elevation.

In the main, only slight sheet erosion characterizes this unusually well protected drainage area. Here and there gullying was noted, but it could not be termed serious.

No accurate data on land use could be obtained. The writer, after observing a considerable portion of the watershed, estimates proportions of land use as follows:

	Percent
Forest (principally scrub timber)....	65
Pasture (including abandoned farm land)......	25
Cultivated..........................	10

The largest single crop from point of acreage is corn. Tomatoes and apples are important products. Tobacco is raised on a somewhat smaller scale.

The method of raising tomatoes deserves mention. Rocky, organic soil of the hilltops and slopes is especially suited. Small fields chosen from the woodland are cleared of underbrush, the trees being "ringed" a season or two in advance and left to die in order to permit sunlight to reach the ground. Often these fields are used but one season, due, it is said, to disastrous effects of mold on the plants of subsequent seasons. Depletion of the scanty soil is probably another factor. After being used a season or two, the little fields are abandoned for others which had been "ringed" and cleared in the same manner.

<u>Mean annual rainfall:</u> 42.89 inches according to the owners.

<u>Power development:</u> The installed power equipment consists of four 60-cycle units with a rating of 5,000 kilovolt-amperes each. The total plant capacity is 20,000 kv-a. There is practically no daily or seasonal draw-down of the reservoir owing to the relative balance between draft and inflow. Draft under full plant operation with full reservoir is 5,500 cubic feet per second.

HISTORY OF SURVEY

The sedimentation survey of Lake Taneycomo was begun on July 23, 1935, and was carried on continuously until Nov. 2, 1935. All work was done by the Central Reservoir Party, Section of Hydrodynamic Studies, Division of Research, under the direction of Thomas L. Kesler. Other members of the party were Louis M. Glymph, Jr., E. M. Flaxman, L. H. Barnes, H. L. Fischer, and O. D. Price.

The topography bordering the reservoir had been mapped by plane table in 1927 on a scale of 500 feet to the inch, and blueprints of the sheets were furnished by the owners as a basis for

the 1935 survey. No original survey of the basin was made. Permanent benchmarks established by the owners are located at intervals along the reservoir, and were indicated in the previous mapping. These tablets were used in the present survey both as take-off points for traverse work and as elevation data.

The exact crest line was not mapped in 1927, and the nearest contour, 1.27 feet higher, merely reflected the approximate shore line of that date. Marginal deposits and islands had altered the original condition, and progressive deposition since 1927 has rendered even that shore line obsolete. It was therefore necessary to re-map all areas showing changes in shore line in order to show the 1935 condition. The real problem then became that of reconstructing the original shore lines for comparison and for use in computations.

Only the range method of volume determination could be employed, and the great thickness of sediment made it necessary to use ths soil auger entirely for thickness measurements. Work could not be carried on rapidly due to the tenacity of the silt and the necessity for uncoupling the drill stem (3/4-inch galvanized pipe) each time it was withdrawn if it exceeded about 20 feet in length. Where shore lines had been built out into the lake and work could be conducted on foot, the process was simpler than in the greater part of the work where it was necessary to bore from the covered front of a rowboat. The auger usually stuck firmly, and two men, by lifting on the handle, would draw the front of the boat well down in the water while a third would grip the stem with a Stillson wrench held flush against the edge of the boat. Thus the front was held low in the water until the other men, grouped in the rear of the boat, rocked it so as to employ the boat itself as a lever. The front would gradually rise, bringing the stem with it, and the process would be repeated until it was possible to pull the auger directly.

In spite of the considerable labor involved, cross sections were carefully evolved with borings made on every surface shot or sounding where breaks in the original profile were suspected, and elsewhere on every second or third position. The rich soil brought in as sediment supports a jungle-like growth which added to surveying difficulties. It was necessary to clear all or part of most survey lines; a conservative check showed that no less than 14,000 feet of these lines were cut in order to lay out the survey network and map shore lines. The growth consisted of willows, sycamores, locusts, and oaks which, due to rich soil and abundance of moisture, commonly attain heights of 50 to 100 feet and a dominant range in diameter of 1 inch to 1 foot. These trees were usually growing upon deposits of sediment built up above crest level.

ACKNOWLEDGEMENTS

Appreciation is expressed to P. J. Seargeant, Chief Engineer of the Empire District Electric Company for complete cooperation throughout the survey, particularly in furnishing blue print of the 1927 survey of the reservoir.

CHARACTER, DISTRIBUTION AND ORIGIN OF SEDIMENT

The writer has found that channel and semichannel reservoirs of the Ozark region, in general, receive their sediment almost entirely during the late winter and spring season of heavy rains. Run-off reaches flood proportions, and the impounding influence of the characteristically low dams is materially reduced, and, in cases of very small reservoirs, practically nullified. Water rises over the surrounding bottom lands causing deposition in the fields. If too sandy, the sediment destroys agricultural values, though subsequent seasons may either remove the sand or cover it with a rich silt-sand mixture restoring fertility for a time. A very small reservoir, the reservoir itself being the channel, offers the most favorable path for unimpeded flood current. The result is partial or complete flushing of the reservoir.

Lake Taneycomo is large enough to check inflowing currents sufficiently to induce at least partial deposition, but flushing occurs in the upper end. The original gravel floor was found free of silt as far down as segment 61 with the exception of a small, locally induced deposit in segments 63 and 64. Therefore, segment 61 marks the point beyond which the transporting capacity of flood currents is critically impaired.

Beginning on range 0114-0115 with an average silt deposit of nearly 3 feet, a considerable thickness is first reached on range 098-099, where the map (fig. 1) shows a slight widening of the original channel. This range gave the first indication of the wide variation to be expected in the original profile over the remainder of the reservoir. The west hillside is covered by a tight, rocky soil which slopes beneath pre-reservoir stream deposits consisting of two natural levees. The component mixture of silt and fine sand in these levees differs from most of the present lake deposits only in degree of compaction and oxidation due to age and drainage. Incidentally, the levee nearest the lake shows slightly less compaction than the other and is considered by the writer to be somewhat younger. Range end 099 was located on this levee. The river deposits dip beneath present lake deposits, and the latter, built 13 feet above crest level, rest on the usual gravel floor of the original river. A similar lateral lake deposit occurs on the east end of the range.

Following the deposits downstream from range 098-099 to the dam, the average silt thicknesses were found to range from 7.5 to 15 feet, although most of them were between 10 and 15 feet. The influence of Bull Creek on sedimentation proved less than might have been expected. Its deposit, beginning as a thin layer, increases more or less gradually until at its mouth it reaches a thickness equal to that of the main body. It may be noted here that the apparently heavily silted horseshoe bend on Bull Creek actually has received a much smaller average thickness of silt than is shown on ranges immediately above and below. Deposition, at least below this bend, may be influenced by diffusion of silt-laden run-off from the upper White River watershed at times when the Bull Creek inflow is low and clear. This is possible in any reservoir with a large drainage area which impounds backwater on more than one stream.

Monotonous geological conditions in the watershed are responsible for silt which, considering its volume, is remarkably uniform in character. In color it varies from reddish brown to very dark brown with no abrupt changes horizontally or vertically except the stratification mentioned below. Samples brought up from the submerged deposits are usually quite dark, becoming lighter upon drying. Sand is a varying constituent, and may be said roughly to be rather prominent in the upper half of the reservoir but of decreasing coarseness and abundance downstream. Strata ranging in composition from very sandy silt to pure fine sand were commonly encountered even in the lower half, however, indicating variation in the force of flood currents.

The most outstanding feature of sedimentation has been lateral deposition, a normal result of the river's preservation of a channel for its flood currents. Where original low bottom lands formed terraces narrowing the channel, opportunity for building great lateral deposits diminished with the necessity for utilizing most of the original channel as a passage. Average thicknesses of sediment in these areas, therefore, run low in spite of spectacular areal changes due to the building of sediment above crest level on the originally shallow marginal terraces. Ranges 039-040, 041-042, and 049-050 illustrate this tendency. On the other hand the greatest average thicknesses were frequently found on ranges exhibiting no great migration shore line, as shown by ranges 03-04, 035-036, and 047-048. The positions of these ranges make them representative of normal depositional processes. An excellent example of lateral deposition high above crest level was found on range 098-099, where widening of the original channel rather than submerged terraces induced great changes in shore lines. Range 087-088 is an equally good example of lateral deposition. In this case deposition took place on one side only, apparently being influenced by deflection of the current toward the outside of the bend immediately downstream. Average thicknesses on the bends themselves were rather low, since aggradation on the inside is nearly offset in each case by degradation on the outside.

Specific silt thicknesses are not of the same importance under these extreme conditions as in more normal basins. After reaching crest level, the deposits continue to grow vertically due to high flood waters. Thus a tremendous amount of sediment rests above crest level both on lake deposits and on original profile. It was, therefore, necessary to plot cross sections from boring data before the original lake margin could be reconstructed. A striking lack of parallelism between the original valley floor and the surface of the silt deposits was brought out by the cross sections. In this absence of parallelism of original and present profiles the advanced sedimentation in channel reservoirs was found to differ markedly from that occurring in broad basins, where uniform thicknesses and parallel profiles are the rule.

The nature of the watershed promotes the addition of much organic matter to the silt, and it was not unusual for considerable bubbling of gas to follow withdrawal of the auger. The most noteworthy instance occurred on the outside edge of the great bar crossed by range 062-063, and formed by conflicting White River and Bull Creek

currents. A boring was made through 21.2 feet of silt in which two thin beds of pure sand were penetrated. Violent sputtering occurred on withdrawal. A match was applied to the gas (supposedly methane) and a flame reached 6 feet in height. The location was visited 72 hours later, and sufficient gas was still emanating to provide a 6-inch flame. Upon reboring, the hole proved to have been merely caved in and the "gasser came in" again with its original force and volume. The sand layers were obviously furnishing paths of migration toward the outlet. Masses of leaves accumulated on the bottom of the reservoir frequently generate enough gas to float themselves to the surface, and outboard motors have been stalled in these "rafts".

The accompanying graph (fig. 2) was plotted to observe any change in gradient in the 20-mile stretch of this river which might have been affected by the dam. Both the original and present profiles were obtained by plotting the lowest points found in the original and present channels on each range. The graph is not a longitudinal plotting of sedimentation. In some cases the present channel was found directly above the original, and in others two original channels were found, indicating (1) lateral movement of the stream, (2) original islands, or (3) tributaries from adjacent lowlands.

Excluding a local feature near the upper limit of the reservoir, three definite peaks may be seen in the present profile. On its immediate upstream side, each peak is preceded by one of lesser intensity, the two in each case being approximately three miles in length. A rather sharp bend occurs upstream from each of these peak areas, whereas the peaks themselves occupy comparatively straight stretches of the reservoir between the bends. It is in these straighter reaches that reversal of direction of curvature from one bend to another takes place. It appears that the silting of this reservoir is progressing toward the development of a normal alluvial channel throughout its length, adjusted to the new base level established by the dam. In this adjustment, the maintenance of greater depths on bends and lesser depths in the intervening crossings between bends appears to reflect the general laws of depth variation in natural alluvial streams with sinuous alignment. In the more familiar case of such alluvial streams, as is well known, bends commonly contain relatively deep pools, whereas the points of reversal of curvature, or straight reaches between bends, are comparatively shoal.

As has been indicated previously, the large watershed of this reservoir is unusually well protected against erosion. Pasture and much of the abandoned land are rather well stabilized by grass, and the timberland is very slightly affected by erosion. In spite of these facts, the size of the drainage area in relation to the capacity of the reservoir is so great that the sediment transported is of sufficient quantity to be very damaging to storage capacity. It may be stated definitely that the extreme channel nature of the basin is strongly favorable to the expulsion of silt by direct passage of flood currents. Being highly constricted, the reservoir does not offer the same opportunity for settling as a basin permitting spreading and greater slackening of velocity. The Chief Engineer of the Empire District Electric Company states that it is not uncommon for

several feet of water to pass over the spillway during and immediately after spring floods. Hence the long and effective spillway. It may be assumed, therefore, that if Lake Taneycomo were impounded where topography would permit the same storage in a broad basin, its rate of sedimentation would be radically greater. This conclusion, because of the representative nature of Lake Taneycomo, is applicable to channel reservoirs in general.

The following tabulation is a statistical summary of data relating to Lake Taneycomo, Taney County, Missouri:

	Quantity	Unit
Age: 1/	22.4	Years
Watershed:		
Total area	4,610	Square Miles
Reservoir:		
Original area at crest stage	2,413.83	Acres
Present area at crest stage	1,859.82	Acres
Original storage capacity	43,980	Acre-feet
Present storage capacity	23,714	Acre-feet
Original storage per square mile of drainage area	9.54	Acre-feet
Present storage per square mile of drainage area	5.14	Acre-feet
Sedimentation:		
Delta deposits) Bottom-set beds)	Not measured separately	
Total sediment	20,266	Acre-feet
Accumulation per year average	904.7	Acre-feet
Accumulation per year per 100 square miles drainage area	19.6	Acre-feet
Accumulation per year per acre of drainage area	13.6	Cubic feet
Or, assuming average weight of 1 cubic foot of silt is 100 pounds	0.67	Tons
Depletion of storage:		
Loss of original capacity per year	2.06	Percent
Loss of original capacity to date of survey	46.08	Percent

1/ Storage began March 1913. Date of survey July 23 to Nov. 2, 1935.

Longitudinal Profiles Showing Change in Gradient of

WHITE RIVER & BULL CREEK

Within

LAKE TANEYCOMO

Taney County — Missouri

From March, 1913 to November, 1935

------- 1913 Gradient

——— 1935 Gradient

Scale: { Horizontal: 1" = 4000'; Vertical: 1" = 10' }

June 27, 1936

Profiles - Lake Taneycomo
White River - Missouri

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, Chief

REFERENCE: Profiles From Field	
DRAFTING APPROVAL: H. W. Whitlock	TECHNICAL APPROVAL: Thomas L. Kesler
COMPILED: R.W.W. A.M.S. / TRACED: R.W.W. / CHECKED: R.W.W. A.M.S. / DATE: 6-27-36	R-842


WHITE RIVER
BRANSON
SEDIMENTATION SURVEY
OF
LAKE TANEYCOMO
TANEY CO., MISSOURI
SURVEYED JULY 23 TO NOV. 2, 1935
U.S DEPT. OF AGRICULTURE
SOIL CONSERVATION SERVICE
Scale in feet
LEGEND
Original Spillway Crest
1935 Spillway Crest
Area Silted Above Original Crest
Range
Aug. 11, 1936